TEKA. COMMISSION OF MOTORIZATION AND ENERGETICS IN AGRICULTURE – 2016, Vol. 16, No. 1, 21–24

Intelligent Building: Comfort and Safety

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Received January 10.2016; accepted January 19.2016

Summary. The paper presents the problem of intelligent installations in buildings, their construction and integration with other systems present in the building. Attention has been focused on systems designed to ensure the safety of property and persons residing in different facilities. It also discusses ways to control the microclimate and other aspects of the building so as to obtain the maximum comfort of the people placed in them. Considering its high popularity, the smart installation based on the KNX/EIB standard is further discussed, examples of algorithms for dealing with security threats are given as well as the functions indicated which can improve the comfort of using a facility.
Key words: comfort, safety, integration.

INTRODUCTION

One of the constantly growing industries is broadly-conceived construction. This is caused by the rapid development of technology, especially the IT industry. Thanks to computer programs, it is possible to design newer and newer construction materials, which have better technical parameters. The need to use modern materials is also the result of various legislation, such as construction law act of 7 July 1994 [3], or energy law of 10 April 1997 [4]. As a member of the European Union, Poland has also introduced a strict directive regarding the energy performance of buildings of 19 May 2010 [2]. It says that all buildings constructed after 2020 should be characterised by the minimum energy consumption.

All these solutions directly contribute to increasing the comfort of the occupants of particular facilities. Comfort and safety are the basic assumptions of the newly designed buildings. Comfort is a broad concept and does not necessarily mean the same thing for different people. It is therefore important that the conditions of living could be decided by the building's user himself. The mere use of modern materials and solutions does not provide such a possibility. It is only the introduction of building automation that allows for a permanent adjustment of a dwelling's parameters to individual needs. With the currently used solutions this task is made simpler because virtually all of them use electronic controllers, sensors or actuators. This allows one to easily integrate the various systems and exercise central control over them. This in turn makes it possible to customise the functions of the building to the individual needs of its occupants.

DIVISION OF BUILDING AUTOMATION SYSTEMS

At the market you can meet a lot of systems managing installations in a building. These systems differ from one another both in the merits of the action as well as the transmission medium. In terms of dispersion of the control units of the system we can distinguish:

– systems with the central unit – they are the systems in which one part serves as a central unit. All the installation configuration is stored in the memory of this one module. To this modules signals from the sensors are supplied; after processing these signals in accordance with the stored algorithm, the module controls the actuators. The advantages of this system include: simple structure, lower installation costs and the fact that in the case of the central unit failure the entire system stops functioning. An example of such a system can be Tebis TS by Hager and the central unit TS 100 shown in Figure 1.
– decentralised systems – they are systems in which individual configurations are stored in the memory of the individual modules. In the case of failure of any module only that part of the system stops working which is supported by the failed module; the remaining part of the system is working properly. This is a doubtless advantage of the solution. The downside are greater costs incurred for the construction of the system.

Fig. 1. The Tebis system module TS 100 by Hager

Another feature that distinguishes between the different systems is the transmission medium. In this respect, we distinguish the following systems:

– Bus-based – the devices communicate via a common bus. An example might be a TP-type bus (twisted pair). A system that is based on such a transmission of data is KNX/EIB.
– Radio (RT) – the devices communicate using radio waves. Units with this transmission medium are mainly used in already existing buildings to extend the functionality of installations without interfering in interior design. An example would be the system of F&HOME RADIO by F&F or Xcomfort by Eaton.
– Power line (PL) – where the information between devices is transmitted along the existing network of 230 V.

THE KNX/EIB SYSTEM

Taking into consideration its high popularity in functioning, we will look at the KNX/EIB system. It is an example of distributed systems. Within each module there is a CPU, memory (ROM and RAM) and an interface. As mentioned above, this solution strengthens the system's reliability because failure of one element does not affect the other components. The only limitation of the installation are the functions realised by the faulty module. Modules exchange information with one another via a TP bus [12]. Additionally, the bus is used to power the various modules. Each module has a unique physical address that is assigned to it while programming the system. To ensure that two devices do not communicate at the same time, the installation uses the CSMA/CA collision avoidance system (Carrier Sense Multiple Access with Collision Avoidance) [14]. The KNX/EIB topology is based on a tree structure. Thus the way of distributing the bus inside the building does not pose any restrictions [10]. In this system, the equipment may have the following functions:

– Sensors – these are input devices collecting signals, e.g. a button or various sensors.
– Actuators – these are executive elements such as dimmers, rotation controllers or binary outputs.
– System components – these are the elements necessary for proper system operation. Also, mention may be made of such elements as power supply or linear clutch [9, 15].

In the KNX/EIB system an installation and its operation algorithm are configured in the ETS utility (Figure 2). An algorithm of the whole system is introduced, i.e. the entire system's reactions to particular events.

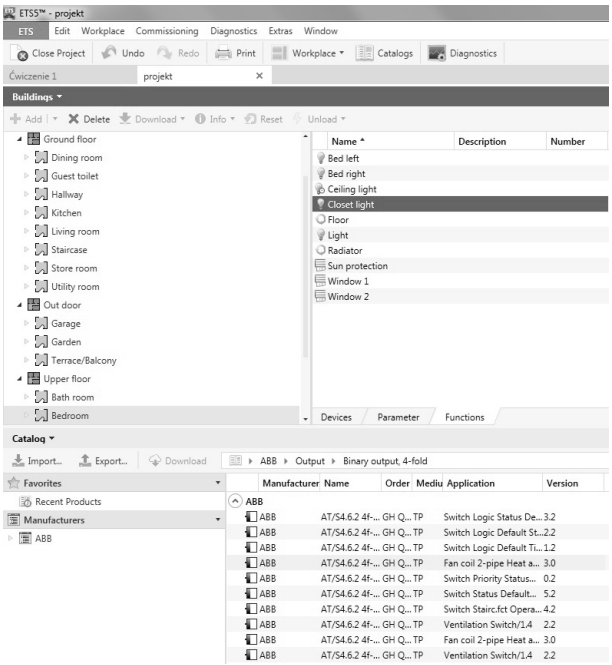

Fig. 2. The application window ETS 5

To properly configure the installation in the ETS 5 program, one should follow the few steps outlined in Figure [3].

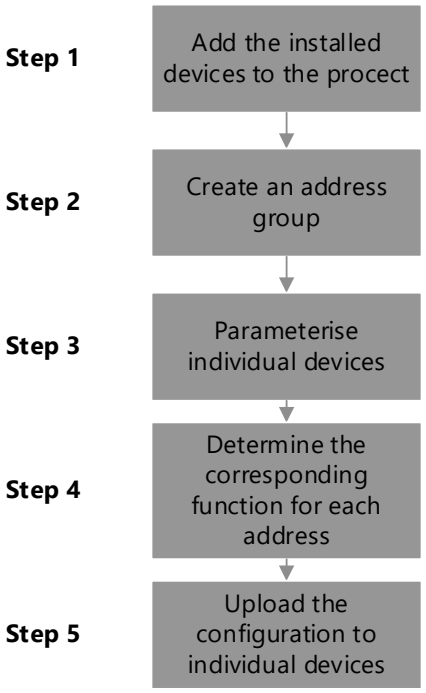

Fig. 3. The procedure for configuring modules in ETS 5

As the devices are programmable. the configuration of the system may be changed at any time. Also, further expansion of the system does not cause any problems.

EXAMPLE OF AN INSTALLATION PROMOTING COMFORT

Each installation found in a certain building has a positive effect on its user's comfort as well as increasing his safety. One such system is the wiring. It provides energy supply and proper operation of the equipment. Because now almost every system includes electrical devices, whether in the form of sensors or controllers, it can be concluded that the installation has a superior role to the others. One of the wiring circuits is used to illuminate the space in the facility.

The use of automation in this circuit is suitable for ensuring optimal brightness indoors through smooth adjustment of the intensity of individual light sources [7].

A proper value of brightness is especially important in the workplace. These values are given in the Polish Standard PN-EN 12464-1:2004 [1]. Because this happens automatically, regardless of the intensity of the external brightness the user is constantly working in optimal conditions, which is shown in Figure 4.

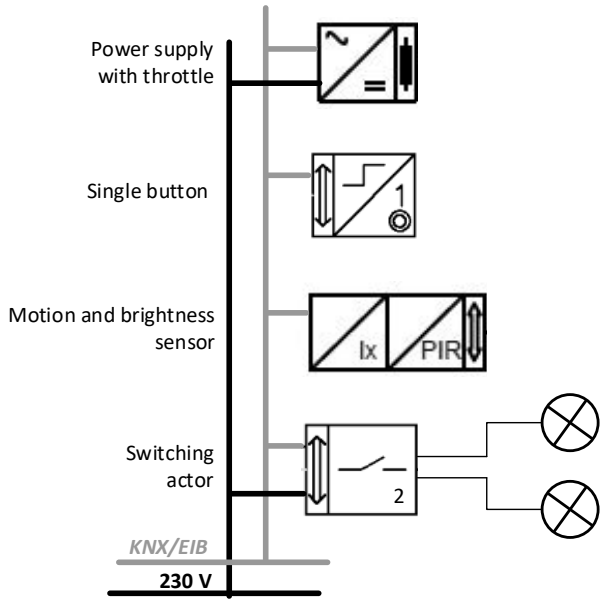

Fig. 4. Automatic adjustment of brightness in the KNX/EIB system

On the other hand, in the case of a rest it is possible to set the so-called light scenes, which provide the right mood in the room. In this case, the light sources in the room should be controlled individually or combined in groups [13].

In recent years one can notice a big impact of the IT industry on building automation systems. Increasingly, traditional control panels in the form of controls and buttons are being replaced by touch screens or smartphones. Access to the building automation via a website is not uncommon. To make it possible, a home server should be attached to the KNX/EIB system as an element that mediates communication between the KNX installation and the Internet [8, 6]. Having this element makes it possible to control the system via the Internet, using visualisation software [11]. These technological advances make it possible to control the work of individual installations in the building from the outside.

SYSTEMS PROMOTING SAFETY

An intelligent installation deployed at a facility not only impacts the comfort, but can also increase the safety of the people residing at the facility. Security realised by an intelligent installation is quite a broad concept, because this installation gathers signals from other installations responsible for security. These include the following:

- Burglary and attack alarm system – SSWiN,
- Access control system – SKD,
- Fire alarm system – SSP,
- Closed Circuit TV system – STVD,
- Public address system – PAS,
- Smoke extract system,
- Fire fighting system [15].

It should be clearly stressed here that an intelligent installation supports the above installations and in no way can it replace them. The building's automation network receives signals from the system and according to the imminent danger adjusts the operation of the other installations. An example of an operation algorithm for an intelligent fire detection system is shown in Figure 5.

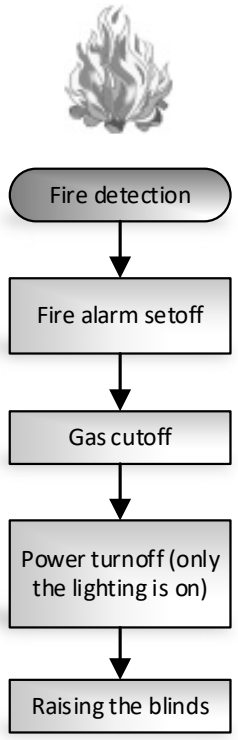

Fig. 5. Example of a BMS reaction to fire

In a similar manner to that shown in Figure 5 one can create operation algorithms for various emergency situations arising in the building. This makes it possible to reduce the potential damage caused by the threat.

CONCLUSIONS

Building automation has been gaining popularity from one year to the next, for example in 2012 in the United States more

than 1.5 million building automation systems were installed [5]. Currently, due to the progressively lower costs, home automation is to a greater or lesser extent located in every building. Depending on how complex it is, it provides additional functions of the building. The essence of building automation lies in the fact that it couples with one another individual installations which have so far operated autonomously. Because the installations exchange signals, they can be centrally controlled, thus enabling new functions of the building. In buildings equipped with "intelligent systems" installations adapt their activity to the threats signalled by other installations. This interaction allows for the creation of appropriate algorithms of action depending on the anticipated risks.

Central control of a building's installations allows the creation of a suitable microclimate for people staying inside it.

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INTELIGENTNY BUDYNEK: KOMFORT I BEZPIECZEŃSTWO

Streszczenie. W pracy przedstawiono zagadnienie stosowania inteligentnych instalacji w budynkach. Ich budowę oraz możliwości integracji z innymi instalacjami występującymi w budynku. Uwaga została skupiona na instalacjach służących do zapewnienia bezpieczeństwa mienia oraz osób przebywających w danych obiektach. Omówiono również sposoby sterowania mikroklimatem i innymi elementami budynku tak aby uzyskać maksymalny komfort osób w nich przebywających. Ze względu na dużą popularność omówiono szerzej inteligentną instalację opartą o standard KNX/EIB, podano przykładowe algorytmy postępowania w przypadku zagrożenia bezpieczeństwa jak również wskazano funkcje które mogą podnieść komfort użytkowania danego obiektu.

Słowa kluczowe: komfort, bezpieczeństwo, integracja, automatyka.